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The effect of electricity consumption from renewable sources on countries' economic growth levels: Evidence from advanced, emerging and developing economies

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ABSTRACT

This paper uses a sample of 36 countries for the time period 1990–2011 in order to examine the relationship between countries' electricity consumption from renewable sources and Gross Domestic Product (GDP) levels. Several nonparametric techniques are applied to investigate the effect of electricity consumption from several renewable sources including wind, geothermal, solar, biomass and waste on countries' GDP levels. When investigating the whole sample ignoring countries' economic development status, the results reveal an increasing relationship up to a certain GDP level, which after that point the effect of electricity consumption on GDP stabilises. However when analyzing separately the ‘Emerging Markets and Developing Economies’, and, the ‘Advanced-Developed Economies’, the results change significantly. For the case of Emerging Market and Developing Economies the relationship appears to be highly nonlinear (an M-shape form) indicating that on those countries the levels of electricity consumption from renewable sources will not result on higher GDP levels. In contrast for the case of the advanced economies the results reveal an increasing nonlinear relationship indicating that higher electricity consumption levels from renewable sources results to higher GDP levels. This finding is mainly attributed to the fact that in the advanced-developed economies more terawatts from renewable sources are generated and consumed compared to the emerging market and developing economies, which traditionally their economies rely on non-renewable sources for power generation and consumption.

Contents

1. Introduction

Since the pioneer work by Kraft and Kraft [1] there has been a growing interest in the literature about the connection between energy consumption and economic growth. Mainly, there are four causal hypotheses regarding this causal relationship [2]. These are the *growth*, *conservation*, *feedback* and *neutrality hypotheses.*[1] More analytically, the *growth hypothesis* implies a unidirectional causality from energy consumption to economic growth. The

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[1] Ozturk [3] presents a detailed review of the four hypotheses

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conservation hypothesis describes a unidirectional causality from economic growth to energy consumption. The *feedback hypothesis* supports the bidirectional causality among energy consumption and economic growth. Finally, the *neutrality hypothesis* describes the case where energy consumption has no significant effect on economic growth and therefore energy conservation policies will not have a significant effect on economic growth.[2]

However it must be mentioned that there is not a clear answer about which hypothesis is correct and the results across the literature are rather mixed failing to establish most of the time the same relationship following Granger causality tests [5,6]. However this may be attributed to the fact that most of the studies use different country samples, for different time periods and from different developed stages [7,8]. Some other studies have focused on a similar manner their research in investigating the relationship between electricity consumption/generation and economic growth.[3] Again when comparing these studies the results provided investigating the causal relationships were mixed [16,17].[4]

In contrast with the pre-mentioned studies, in this paper we provide empirical evidence for the *growth hypothesis* analyzing the effect of electricity consumption from renewable sources (RE) on countries' economic growth levels using the local linear estimator [20,21] without assuming any functional form of the examined relationship [22]. The structure of the papers is the following. The next section presents the relative literature, whereas Section 3 presents the data and the methods used. Section 4 presents the empirical findings from the nonparametric analysis, whereas the last section concludes the paper.

2. A brief literature on the energy consumption economic growth relationship

Ayres [23] supports the feedback hypothesis and argues that primary resource flows (exergy), such as oil, are not just a result of economic growth but they are its principal factors. Mehrara [24] investigates the connection between energy consumption and economic growth in oil exporting countries and finds evidence about the conservation hypothesis. Bowden and Payne [25] analyze the causal relationship between energy consumption and economic growth using a Toda-Yamamoto approach. The authors use renewable and non-renewable energy consumption and as a growth measure they use GDP per sector and confirm the growth hypothesis for residential renewable energy sources (RES) consumption.

Additionally, the neutrality hypothesis explains the commercial and industrial consumption. Ozturk et al. [26] apply a Pedroni [27] panel cointegration approach, a panel causality test and the Pedroni [28] method in order to investigate the causal relationship for 51 countries. The results indicate that energy consumption is cointegrated with GDP. Furthermore, the conservation hypothesis and the feedback hypothesis are confirmed for low and middle income countries respectively. Ozturk and Acaravci [29,30] apply an ARDL approach on five Eastern and Southeastern European countries. The authors study the causal relationship between energy consumption and GDP and they find evidence to support the neutrality hypothesis.

In an alternative study, Asafu-Adjaye [31] argues that there are two contradictory approaches to examine the connection between energy consumption and economic growth. The first approach describes the energy as a limiting factor for economic growth while the second approach assumes a neutral relationship between them. Shi and Zhao [32] confirm the connection among the rise of energy consumption in China and the slightly declined growth rates and Cropton and Wu [33] validate their result. Rodriguez and Sachs [34] argue that intensive-resource economies tend to experience lower growth rates than low-resource economies. Furthermore they explain this paradox with the temporally high growth rates of the intense-resource economy which are considerably above the steady state and they argue that the economy must converge back to its steady state. They demonstrate the case study of Venezuela, which is an oil exporter and an intense-resource country, in order to support the above assumption. Stinjs [35] further supports the above findings. The author claims that a country rich in natural resources does not necessarily imply a country with high economic growth and they also find that the neutrality hypothesis is valid.

Mehrara [24] presents four econometric approaches which according to the author are the most widely used in the literature in order to examine this connection. The first approach applies the conventional VAR methodology and assumes stationarity for the variables. The second approach relaxes the stationarity assumption and uses a Granger [36] two-stage procedure for cointegration. The third approach employs the Johansen [37] methodology, while the last approach applies panel cointegration and panel error correction models.

The popular concept of sustainable development does not conform with the highly dependence of the global economy on fossil fuels which are considered as one of the main reasons for global warming and climate change. The most widely used fossil fuels are oil, gas and coal and they produce various harmful gases such as CO_2 and SO_2. Moreover as we have already presented, the majority of the literature indicates a connection between energy and economic growth. If we combine this connection with the concept of sustainable development then we can understand that a more environmental-friendly path is needed which can be achieved by using sustainable energy sources.

Substituting fossil fuels with renewable energy sources (RES) will reduce the emissions and therefore the global pollution. The most important RES are solar, wind, geothermal, biomass, hydroelectricity, wave and tidal energy sources. Apergis and Payne [38] mark the significance of this substitution because of three reasons. First, the volatility of oil price might be a destabilizing economic factor. Awerbuch and Sauter [39] also support this view. They investigate the connection between oil and economic growth and they find the significant effect of price volatility of oil on economic growth. Specifically, a 10% increase in oil price will result in 0.5% loss of the global GDP. This negative effect is contributed to inflation and unemployment.

The second reason of Apergis and Payne [38] is that non-renewable energy sources such as fossil fuels cause environmental degradation and contribute to global warming. Third, countries which use RES as their primary fuels are not depending on countries which are “energy-producers”. Bowden and Payne [25] propose a number of incentives for the promotion of RES which include tax credits and renewable energy standards.

Furthermore, international agreements are a significant contributor towards the substitution of fossil fuels with RES. One of the most important international agreements for the promotion of RES and the reduction of greenhouse gases is the Kyoto Protocol which was created through the United Nations Framework Convention on Climate Change (UNFCC). Another important agreement is the Renewable Energy Directive (2009/28/EC) of European Commission which sets objectives for the European Union members. These objectives include among others that the 20% of total energy and the 10% of transport energy to come from RES by

[2] For a meta analysis of the empircal studies of the energy consumption GDP studies see Menegaki [4]

[3] Ghosh [9,10] for the case of India, Altinay and Karagol [11] for Turkey, Aqeel and Butt [12] for Pakistan, Jumbe [13] for Malawi, Shiu and Lam [14] for China and Murry and Nan [15] for East Asian countries.

[4] For an extensive literature review of studies investigating the causal relationship between electricity/energy use and economic growth see Lee [18,19].

Table 1
Descriptive statistics of the variables used.

Real GDP at chained PPPs (in mil. 2005US$)											
Year	***1990***	***1991***	***1992***	***1993***	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***
Mean	853297.00	872121.05	879003.53	909376.82	945368.25	988340.96	1021978.23	1055837.29	1068947.70	1105954.13	1164975.93
Std	1432173.34	1442634.53	1465812.06	1516400.44	1578806.17	1633467.77	1691573.58	1762027.01	1822407.40	1906348.37	1991311.37
Min	59045.98	59620.46	63567.60	66246.90	70053.45	77840.90	79206.96	81718.01	83765.89	89037.73	92620.03
Max	7963012.00	7925629.50	8211394.50	8469315.00	8842204.00	9071050.00	9430334.00	9869378.00	10309118.00	10807267.00	11275426.00
Year	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***
Mean	1185840.70	1211299.85	1246252.39	1306651.24	1378218.84	1428579.10	1500818.40	1539125.41	1539424.99	1596276.20	1648283.73
Std	2019557.25	2066191.23	2135077.14	2231294.01	2327630.41	2382873.51	2498547.74	2564075.51	2602210.02	2633978.06	2748541.92
Min	95492.48	98469.09	100061.89	98991.92	101895.02	101978.76	104614.86	100917.83	105678.38	105612.28	103125.67
Max	11368939.00	11515518.00	11789128.00	12196382.00	12564300.00	12564300.00	12898268.00	13149344.00	13066677.00	12597854.00	13193478.00
Primary energy consumption from renewable sources measured in Terawatt, h/yr											
Year	***1990***	***1991***	***1992***	***1993***	***1994***	***1995***	***1996***	***1997***	***1998***	***1999***	***2000***
Mean	3.23	3.41	3.64	3.79	3.97	4.13	4.34	4.66	4.98	5.41	5.80
Std	10.36	10.99	11.72	12.10	12.15	11.65	11.96	12.20	12.16	12.56	12.78
Min	0.07	0.07	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.08
Max	63.75	67.68	72.31	74.72	74.81	71.74	73.52	74.74	74.44	76.80	78.15
Year	***2001***	***2002***	***2003***	***2004***	***2005***	***2006***	***2007***	***2008***	***2009***	***2010***	***2011***
Mean	6.05	6.84	7.42	8.45	9.47	10.57	12.05	13.77	15.79	18.62	21.96
Std	12.23	13.77	14.10	15.07	16.20	18.03	20.33	23.58	26.55	30.96	36.73
Min	0.12	0.13	0.13	0.25	0.28	0.37	0.49	0.49	0.49	0.49	0.49
Max	74.18	82.81	83.17	86.81	91.14	100.45	109.29	130.35	148.69	171.89	200.09

2020.[5] In addition, European country members are encouraged to set individual goals towards 2020.

So far we have presented studies about the relationship of energy and economic growth. It is interesting to examine specifically the relationship between RES and economic growth. Chien and Hu [40] support the growth hypothesis. They apply Structural Equation Modeling at 116 countries and they examine the relationship between RES and GDP. They decompose GDP and find that RES promotes growth through capital formation but not through trade balance. The conservation hypothesis is supported by Sadorsky [41] who applies a panel cointegration approach to study the RES consumption in G7 countries. The findings reveal that GDP per capita has a significant effect on RES consumption. Sadorsky [42] finds similar results for 18 developing economies during the period 1994–2003. In particular, the author applies a panel cointegration and a vector error correction model and validates that per capita GDP has a significant positive influence on RES consumption.

Apergis and Payne [2] investigate 13 Eurasian countries during the period 1992–2007 using a multivariate panel model. They confirm the feedback hypothesis both in short and long run. Apergis and Payne [38] and Apergis and Payne [43] in similar studies about 20 OECD countries and 80 countries respectively, also validate the feedback hypothesis. Tugcu et al. [44] apply an ARDL approach to investigate the relationship between RES and non-RES consumption and economic growth for G7 countries. The results confirm the feedback hypothesis for both RES and non-RES consumption. Pao and Fu [45] investigate the connection between various energy sources including RES and economic growth in Brazil. In all cases they find evidence about the feedback hypothesis. Menegaki [46] applies a random effects model to investigate the case of 27 European countries to examine the relationship between RES consumption and GDP and finds evidence about the neutrality hypothesis. Yildirim et al. [47] also support the neutrality hypothesis in a study about RES in USA.

Interesting insights are provided by Chang et al. [48] who investigate the relationship of energy prices and under different levels of economic growth in OECD countries during the period 1997–2006. The authors apply a panel threshold regression model and they find that on the one hand countries with higher growth rates tend to increase RES consumption when energy prices increase, thus supporting the conservation hypothesis. On the other hand, countries with lower growth rates do not respond to energy prices volatility which supports the neutrality hypothesis. Ocal and Aslan [49] investigate the relationship among RES and economic growth in Turkey. The authors apply an ARDL methodology and Toda-Yamamoto causality tests. The results from ARLD methodology reveal a negative effect of RES on economic growth. The results from the causality tests show support conservation hypothesis because economic growth seems to affect RES consumption.

3. Data and methodology

In order to examine the relationship between electricity consumption from renewable sources and economic growth, we use a sample of 36 advanced/developed and emerging market/developing economies[6] for the time period of 1990–2011. Table 1 presents diachronically the descriptive statistics of the variables used. In our nonparametric regression context we are using as dependent variable real GDP at chained PPPs (in mil. 2005 US $) extracted from Penn World Table-PWT v8.0 [51]. According to Joehnson et al. [52] two-thirds of all cross-country empirical work is based on data derived from different versions of Penn World Table (PWT). As Joeknson et al. [52] suggest that the main advantage of PWT is to produce measures of real GDP which are comparable among countries and over time. According to Feenstra et al. [51] PWT v8.0 is more consistent over time and more transparent in its methods. Therefore we extract the real GDP measure from PWT alongside with the electricity consumption derived from renewable energy sources (RE- explanatory variable) including wind [53–55], geothermal [56,57], solar [58–61], biomass and waste [62–67] and not accounting for cross border electricity supply.[7] Given the data limitation of the RE variable, our final sample contains 36 countries for the period 1990–2011. Alongside with Table 1, Table 2 provides detail information of

Table 2
Countries' availability of renewable energy sources, total electricity consumption and GDP levels for 2011.

Countries	*Wind power*	*Biomass*	*Solar power*	*Geo thermal*	*Total Electricity Consumption (Terawatt, h/yr)*	*Real GDP at chained PPPs (in mil. 2005 US$)*
ARG	*	*			120.86	543098.69
AUS	*	*	*	*	239.31	769988.56
BEL	*	*	*		88.62	320316.50
BRA	*	*			480.12	1702745.75
CAN	*	*	*	*	565.73	1108343.00
CHE	*	*	*		62.73	342790.81
CHL	*	*			61.76	236423.41
CHN	*	*	*		4432.90	10845615.00
COL	*	*			52.86	362684.13
CZE	*	*	*		66.01	221607.58
DEU	*	*	*	*	579.21	2861993.00
DNK	*	*	*		34.10	183887.17
ESP	*	*	*		258.48	1273929.13
FIN	*	*	*		84.80	175558.58
FRA	*	*	*		476.5	1952681.88
GBR	*	*	*		346.16	1915655.63
GRC	*	*	*	*	59.85	254160.55
HUN	*	*	*		38.84	160982.05
IDN	*	*	*	*	165.71	1021814.19
IND	*	*			835.40	4661976.00
IRL	*	*			26.09	185337.83
ITA	*	*	*	*	327.47	1765958.63
JPN	*	*	*	*	1003.09	4031049.25
KOR	*	*	*		505.86	1416487.50
MEX	*	*	*	*	249.67	1378161.63
NLD	*	*	*		117.45	621234.00
NOR	*	*	*		114.78	250392.56
NZL	*	*		*	41.40	103125.67
PHL	*	*	*	*	61.50	330771.88
POL	*	*			147.67	675404.69
PRT	*	*	*	*	51.19	223909.94
RUS	*	*		*	927.21	2402078.75
SWE	*	*	*		132.57	324806.81
TUR	*	*		*	197.94	1097894.00
TWN	*	*	*		220.8	694949.69
USA	*	*	*	*	4127.31	13193478.00

The asterisk (*) indicates country's availability of a specific renewable energy source

[5] http://www.seai.ie/Publications/Statistics_Publications/Statistics_FAQ/Energy_Targets_FAQ/

[6] **Advanced-developed countries (23)**: Australia, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Japan, Korea Republic of, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, Taiwan, United Kingdom and the United States of America. **Emerging market-developing countries (13)**: Argentina, Brazil, Chile, China, Colombia, Hungary, India, Indonesia, Mexico, Philippines, Poland, Russia, Turkey [50].

(footnote continued)

[7] The data has been extracted from the Statistical Review of World Energy and are available from: http://www.bp.com/

the availability of countries' renewable sources [68], for total electricity consumption [69] and from real GDP levels for 2011.

Since we cannot assume a specific functional form for the examined relationship we apply nonparametric techniques which are not restrictive to any functional forms. Let the dependent variable (GDP) be denoted by y_i and let the independent variable $X_i$represents the energy consumption derived from renewable sources. We assume that the examined variables are continuous with a joint density$f(y,x)$, having a marginal density of X_i which can be defined as $f(x) = \int f(y,x)\,dy$. In this way the conditional density of y_i given X_i can be defined as $f(y|x) = f(y,x)/f(x)$. Then in a nonparametric setting the following regression function will take the form:

$$g(x) = E(y_i|X_i = x). \tag{1}$$

Following Li and Racine [22, Theorem 2.1, p. 59] the regression function can be written as

$$g(x) = \frac{\int yf(y,x)\,dy}{f(x)}, \tag{2}$$

Thus we can estimate gby replacing the density functions by their nonparametric estimates. Therefore the estimate of the joint density can be computed non-parametrically as:

$$\hat{f}(y,x) = \frac{1}{n|H|h_y} \sum_{i=1}^{n} K(H^{-1}(X_i - x))k\left(\frac{y_i - y}{h_y}\right). \tag{3}$$

Where h_y is a bandwidth for smoothing in the y direction, whereas $H = diag(h_1, ..., h_q)$.

In addition $K(.)$ is a product kernel function and $K(.)$is a univariate kernel function that satisfies the following conditions:

$$\int k(u)du = 1, k(u) = k(-u), \int u^2 k(u)du = \kappa_2 > 0. \tag{4}$$

In Eq. (4) $k(u) = \frac{1}{\sqrt{2\pi}} e^{-\frac{1}{2}u^2}$, $-\infty < u < \infty$ denotes the Gausian kernel [22, p. 8–11]. Moreover, the nonparametric estimate of marginal density of X_i can be defined as:

$$\hat{f}(x) = \int \hat{f}(y,x) = \frac{1}{n|H|h_y} \sum_{i=1}^{n} K(H^{-1}(X_i - x)) \int k\left(\frac{y_i - y}{h_y}\right) dy$$
$$= \frac{1}{n|H|} \sum_{i=1}^{n} K(H^{-1}(X_i - x)), \tag{5}$$

and

$$\int y\hat{f}(y,x)dy = \frac{1}{n|H|h_y} \sum_{i=1}^{n} K(H^{-1}(X_i - x)) \int yk\left(\frac{y_i - y}{h_y}\right) dy$$
$$= \frac{1}{n|H|} \sum_{i=1}^{n} K(H^{-1}(X_i - x))y_i. \tag{6}$$

Finally, the local linear estimator [20,21] can be obtained as:

$$\min_{\{a,b\}} \sum_{j \neq 1, j=1}^{n} [Y_j - a - (X_j - X_i)'b]^2 K\left(\frac{X_j - X_i}{h}\right). \tag{7}$$

where $K\left(\frac{X_j - X_i}{h}\right) = \prod_{s=1}^{q} k\left(\frac{X_{is} - X_{js}}{h_s}\right)$. Then let $\hat{g}_{-i,L}(X_i)$denote the leave-one-out linear estimator of $g(X_i)$ and $\left(\hat{a}_i, \hat{b}_i\right)$ be the solution of (a,b), then $\hat{a}_i \equiv \hat{g}_{-i,L}(X_i)$.

Following Li and Racine [22, p. 83] the local linear least squares cross-validation approach is introduced by choosing $h_1, ..., h_q$to

Table 3
Results from the nonparametric regression.

Model summary	Bandwidth	p-value	R-squared
RE (All economies)	34.01587	0.0254**	0.4036
RE (Advanced economies)	31.82791	0.0000***	0.5460
RE (Emerging market and developing economies)	19.07234	0.0411**	0.2022

*10%.
** 5%.
*** 1% significance level.

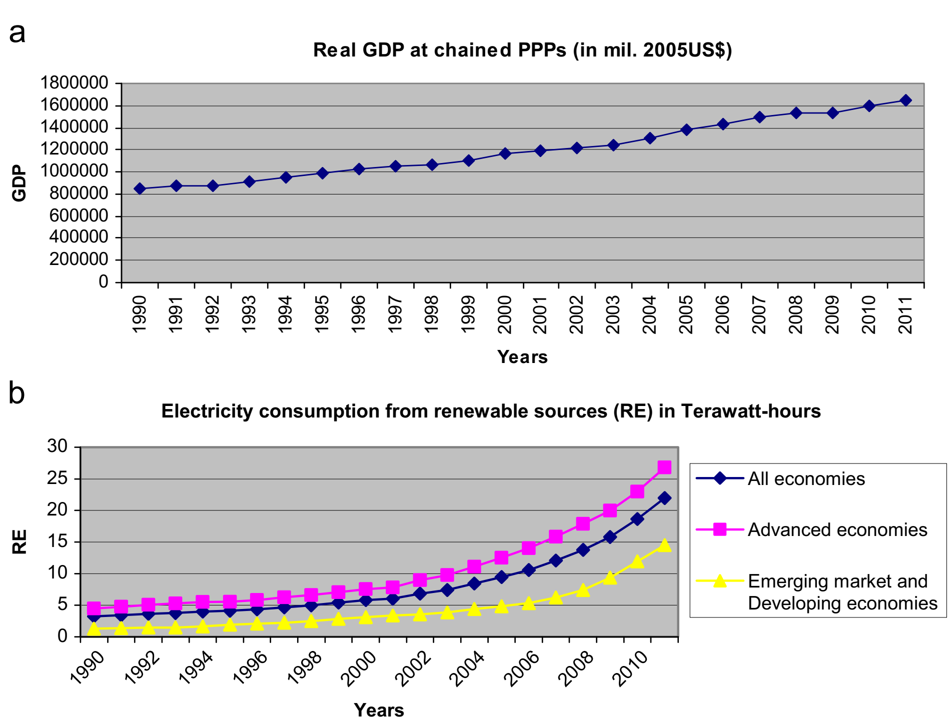

Fig. 1. Diachronical representation of the variables.

minimize the objective:

$$CV_{ll}(h_1, \dots, h_q) = \min_h n^{-1} \sum_{i=1}^{n} \left(Y_i - \hat{g}_{-i,L}(X_i)\right)^2 M(X_i), \tag{8}$$

where $\hat{g}_{-i}(X_i) = \sum_{l \neq i}^{n} y_l (K(X_i - X_l)/h) / \sum_{l \neq i}^{n} (K(X_i - X_l)/h)$, which is the leave-one-out kernel estimator of $g(X_i)$ and $0 \leq M(.) \leq 1$ is a weight function.

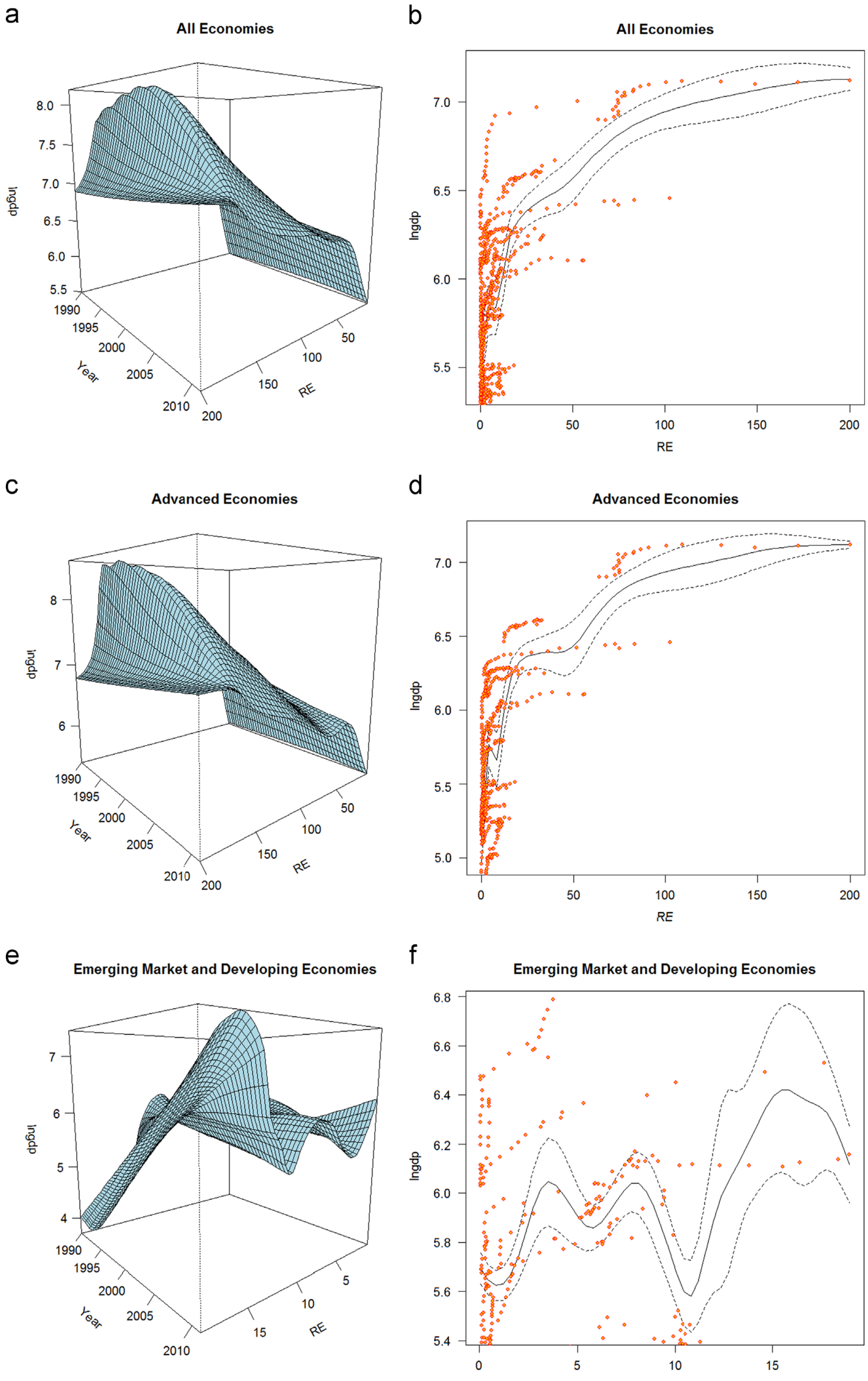

Fig. 2. Graphical representation of the effect of renewable electricity consumption (RE) on countries' GDP levels.

4. Empirical results

Looking at the diachronical representation of the variables used (Fig. 1) we can see an increasing trend for countries' GDP levels (Fig. 1a) and for electricity consumption from renewable sources (Fig. 1b). More analytically, advanced and developed countries appear to consume diachronically more levels of electricity derived from renewable sources compared to the emerging market and developing countries.

Following the bootstrap algorithms introduced by Racine [70], Racine et al. [71] and Racine [72] we test the significance of the independent variable (RE). Table 3 presents the obtained *p-values* of the nonparametric significance test alongside with the selected bandwidths following the local linear (ll) least squares cross-validation approach introduced by Li and Racine [22].[8] The results reveal that the electricity consumption from renewable sources (RE) is statistical significant for all the examined cases explaining countries' growth variation. Moreover, the obtained R-squared values signify that the RE variable explains 54% for the advanced and developed countries' economic growth variations in contrast with the emerging market and developing countries which explains only the 20% of their economic growth variations. This finding suggests that developing countries find their comparative advantage shifting to higher polluting production sectors using conventional energy sources [73].

Fig. 2 presents schematically the relationship between electricity consumption from renewable sources and countries' GDP levels alongside with asymptotic error bounds. When the full sample (Fig. 2a and b) is examined the nonparametric regression line indicates an increasing trend between RE and countries GDP levels. Moreover a similar picture appears in the case of advanced/developed economies. More analytically subfigure 2c presents also the time effect in contrast with Fig. 2d which presents only the effect of electricity energy consumption from renewable sources on countries' GDP levels. The results reveal that the effect of time (Year) has a positive effect on countries' GDP levels alongside with RE.

When examining only the effect of RE on advanced economies' GDP levels it appears that the effect is highly positive in a nonlinear manner indicating that for advanced economies electricity consumption from renewable sources can be a source of economic growth. However we cannot conclude the same in the case of emerging market/developing economies (Fig. 2e and f). As reported in Fig. 2e the effect of time is highly positive for developing countries' GDP levels. Moreover it can be said that is more positive to their economic growth levels compared to the developed economies. This is indicated from the highly increasing trend.

However it cannot be justified the same for the RE variable. In fact looking at Fig. 2f a nonlinear relationship can be observed indicated by a ‘M’ shape up to a consumption level of 10 terawatts per hour. After that consumption level the trend is increasing and then decreasing again forming an inverted ‘U’ shape. Several authors suggest that this phenomenon is attributed to the inefficient electrification programs using RE for those countries [75,76].

Moreover, other reasons may be attributed to high cost of transmission and distribution, institutional weaknesses and inappropriate policy framework [76]. Finally, Beck and Marinot [77] suggest that the barriers and lack of implementation of renewable sources in emerging market and developing countries is mainly attributed to (a) costs and pricing issues, (b) legal and regulatory policies and (c) market performance factors. More analytically they suggest that barriers related to cost and pricing involve subsidies for competing fuels, high initial capital costs, difficulty of fuel price risk assessment, unfavorable power pricing rules, transaction costs and environmental externalities.

In addition, barriers to renewable sources related to legal and regulatory aspects include issues related to the lack of legal framework for independent power producers, restriction on sitting and construction, transmission access, utility interconnection requirements and liability insurance requirements. Finally according to Beck and Marinot [77] barriers related to market performance include lack of access to credit, uncertainty and risk related to perceived technology performance and lack of technical or commercial skills and information.

[8] For our estimations we have use the ‘np’ programme which is an integrated R-package developed by Hayfield and Racine [74]

5. Conclusions

This paper analyses the effect of electricity consumption from renewable sources on countries’ economic growth. Based on the *growth hypothesis* our paper applies a local linear estimator in order to analyze the examined relationship both for a sample of advanced/developed and emerging market/developing countries for the period 1990–2011.

The empirical findings reveal a positive relationship for the sample of advanced economies indicating that electricity consumption from renewable sources is a vital contributor to economic growth. However for the developing economies the relationship is nonlinear indicated by a ‘M’ shape relationship up to a consumption level of 10 terawatts per hour.

However for higher consumption values of 10 TWh the relationship forms an inverted ‘U’ shape relationship. Mainly this phenomenon is attributed to barriers and lack of implementation of renewable sources based on costs and pricing issues, legal and regulatory policies and market performance factors.

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